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UNITED STATES
DEPARTMENT OF THE INTERIOR
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BUREAU OF MINES
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INFORMATION CIRCULAR

NONMETALLIC MINERALS NEEDED FOR NATIONAL DEFENSE:

1. FERTILIZER MATERIALS

BY

BERTRAND L. JOHNSON

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

NONMETALLIC MINERALS NEEDED FOR NATIONAL DEFENSE:

1. FERTILIZER MATERIALS[1]

By Bertrand L. Johnson[2]

Fertilizers are indispensable to national preparedness and defense. Production of adequate supplies of nourishing food for sustaining life in the United States is absolutely dependent in many parts of the country on the use of artificial fertilizers of various types. Only by using fertilizers can we maintain our present volume of production without great additional expense. Otherwise we would have to increase crop areas constantly to compensate for declining yields, we would have to lower the quality of food marketed, and standards of farm living and rural civilization would decline.

About 60 million of the 360 million acres of crops grown annually in the United States now require fertilizing each year, and between 7 and 9 million tons of commercial fertilizers are consumed annually for this purpose.

DOMESTIC CONSUMPTION

During the last 30 years annual domestic consumption of commercial fertilizers has fluctuated between a minimum of 4 million and a maximum of over 8 million tons, the average having been 6-1/2 million tons. In the World War of 1914-1918 the range was from 5 to 7 million tons a year, but in recent years it has increased to 4 to 8 million tons. The cyclical swings since 1910 have been of increasing amplitude, with gradually rising peak productions and falling bottoms of the depressions. (See fig. 1.) The normal trend line over this period is virtually horizontal at about 6 million tons. The following table shows consumption, by years, from 1910 to 1939, inclusive, of fertilizers moving through regular commercial channels.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7159."

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Fertilizer consumption in the United States, 1910-39
(Data from National Fertilizer Association.
Fertilizer Review, March-April 1940, p. 12)

Year	Short tons	Year	Short tons
1910	5,453,000	1925	7,334,000
1911	6,024,000	1926	7,329,000
1912	5,767,000	1927	6,844,000
1913	6,337,000	1928	7,986,000
1914	7,100,000	1929	8,012,000
1915	5,324,000	1930	8,222,000
1916	5,125,000	1931	6,354,000
1917	5,926,000	1932	4,385,000
1918	6,467,000	1933	4,908,000
1919	6,626,000	1934	5,583,000
1920	7,177,000	1935	6,274,000
1921	4,863,000	1936	6,902,000
1922	5,671,000	1937	8,196,000
1923	6,443,000	1938	7,489,000
1924	6,826,000	1939	7,539,000

As a result of the loss of export markets for cotton and tobacco - important fertilizer-using crops - and the close domestic control of productive acreage (acreage goals for 1941 being little changed from those for 1940) fertilizer consumption in the near future is expected to increase little if any. Current consumption is above the average of the past 30 years. During that period the horizontal trend was established with wide cyclical fluctuations. Future annual consumption will probably be within the limits established by the diverging lines shown in figure. 1, and in the near future in the neighborhood of 7 to 9 million tons a year.

A purely statistical forecast, with no allowances for the impact of national defense and the aid-to-Britain programs, indicates that the present annual consumption of about 7-1/2 million tons could increase substantially. It is likely that the plant-food content per ton of fertilizer likewise will continue to increase.

PRODUCTIVE CAPACITY

Present capacity for fertilizer production, according to industry reports, is twice as great as the consumption of any past year.3/ A survey by the National Fertilizer Association in 1938 showed4/ that with present equipment and normal working periods the United States was capable of manufacturing 16,464,000 short tons of commercial fertilizer, twice as much as this country has ever used in one year. It appears likely that considerably more than is now used or is likely to be used for years to come could be

3/ Fertilizer Review, The Fertilizer Industry in the National Defense: Vol. 15, No. 4, August-September 1940, pp. 4-5.
4/ Fertilizer Review, Overcapacity Shown by Factory Survey: Vol. 13, No. 2, March-April 1938, p. 12.

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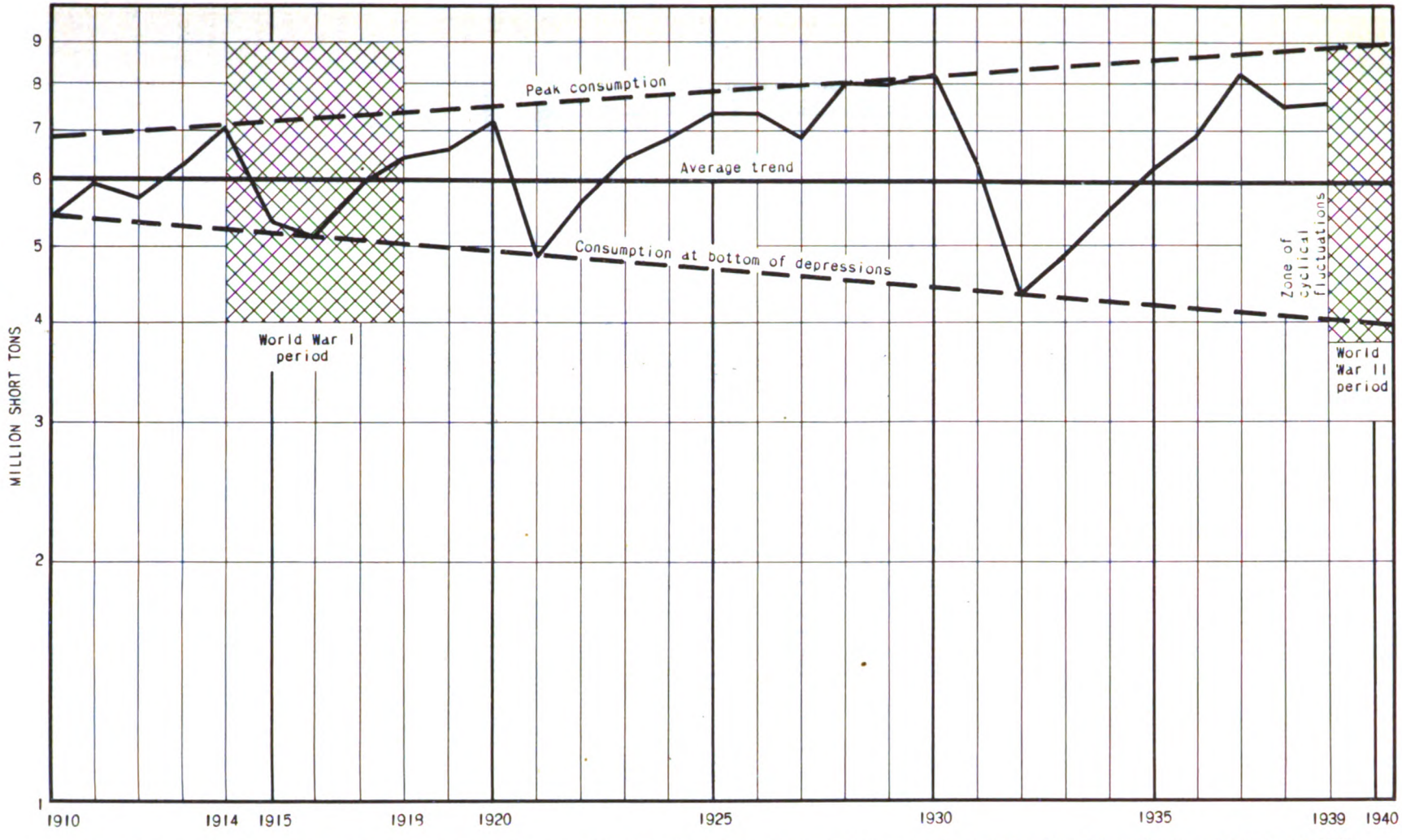

Figure 1.- Fertilizer consumption in the United States, 1910-39. (Data from National Fertilizer Association Fertilizer Review, March-April 1940, p. 12.)

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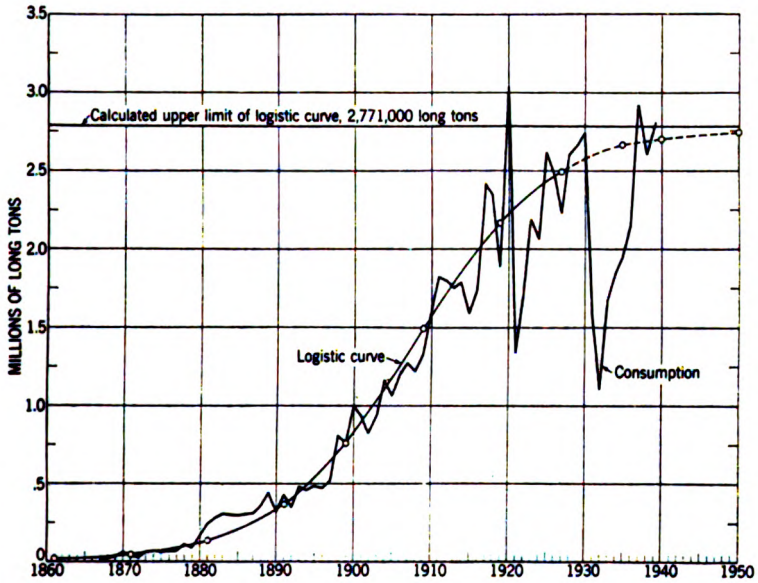

Figure 2.- Consumption of phosphate rock in the United States, 1867-1939.

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manufactured, even if conditions during the next few years should make necessary an increase in crop production with a consequent increase in demand for fertilizers.

RAW-MATERIAL NEEDS

The productive capacity of existing fertilizer plants has been shown greatly to exceed current needs or prospective future demands; but, and more particularly in view of the larger consumption of plant nutrients per ton of fertilizer, can producers obtain the necessary raw materials to maintain current rates of production or to supply any possible increase in demand for their products under existing conditions or a war economy? As many as 22 elements have been considered necessary for plant growth. Most of these, however, are sufficiently abundant in most soils for the growth of well-nourished plants. Only three - nitrogen (N), phosphorus (P), and potassium (K) - are applied regularly and in large amounts and need be considered in the present emergency.

As yet the United States has shown itself to be self-sufficient in only one of these three elements - phosphorus. In the case of nitrogen and potassium self-sufficiency had not been attained up to 1941, although there are indications that potassium will attain that status in the near future, and it is stated that domestic capacity for producing nitrogen can be increased to meet the deficiency of about 30 percent by which our domestic supply fails to satisfy our normal requirements. In respect to nitrogen, however, there is the further factor that, although fertilizers normally take by far the bulk, say 85 percent, of our consumption, the manufacture of explosives may demand much greater quantities as a result of the defense or military emergency.

The fertilizer raw materials do not consist of the fertilizer elements nitrogen, phosphorus, and potassium as such. The materials used are more or less pure chemical compounds of these elements with other elements, or they are complex vegetable or animal materials. To supply each of these elements a variety of substances is available, although in practice choice has been concentrated principally on a relatively few in each case.

Phosphates

The principal phosphatic substances utilized in the United States for fertilizers are the superphosphates, ammonium phosphate, finely ground phosphate rock, and basic slag. The raw material used as a source of phosphorus for the production of the first three commodities is phosphate rock, of which our reserves are virtually unlimited, sufficient at the present rate of consumption (fig. 2) for at least 3,000 years, those in Florida alone being enough for more than a thousand years. There is no question of the adequacy of our supply of phosphate rock under any circumstances, unless Florida is invaded. In such event recourse would have to be had to the Tennessee phosphate field, now supplying only about a third of our needs, both for fertilizer and chemical purposes, and to the only slightly developed Western States field. The production of superphosphates involves the treatment of phosphate rock with sulfuric acid. During the World War of 1917-18 a shortage of acid

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for this purpose occurred because of the demand for large quantities of sulfuric acid for making nitric acid to be used in the manufacture of munitions. Nitric acid was then produced from natural sodium nitrate by treatment with sulfuric acid. It is now made almost entirely by the oxidation of ammonia, so that a shortage of sulfuric acid from demand by that industry is not likely to occur.

Consumption of phosphate rock in the United States since 1860 is shown in the accompanying diagram (fig. 2). Production greatly exceeds domestic demands (fig. 3) - about a million tons a year being exported - and the curtailment of exports as a result of the present world war only increases the relative capacity and supply available to meet domestic requirements. The fertilizer industry is not expected to increase its requirements greatly. The chemical uses of phosphate - which now take about 13 percent of the phosphate rock produced - are growing slowly but not enough to minimize the effects of the fluctuations in demand for agricultural purposes.

The demand for basic slag for fertilizer is not great in the United States and is met by the annual production of a few thousand tons in the Birmingham iron district of Alabama and the importation of a small quantity.

Potash

Self-sufficiency in potash, desirable from a national defense viewpoint, has been approached rapidly in recent years (figs. 4 and 5), and in 1939 domestic potash sales were 96 percent of the apparent domestic K_2O consumption. The present war in Europe has cut off all potash imports from Germany and France, and in recent months our only imports have been a few thousand tons from Spain and Chile. We now depend almost entirely on domestic production.

Domestic resources of potash salts are more than adequate for our own use for many decades, and in September 1940 the annual productive capacity of American plants was about 350,000 tons K_2O in refined potassium chloride and 200,000 tons K_2O in crude run-of-mine chlorides, which is somewhat in excess of domestic demand. It appears probable that our entire K_2O requirements are assured, at least insofar as potassium chloride is concerned.

Exports of domestic potash fertilizer materials have increased gradually in recent years to over 80,000 short tons in 1939, and late in 1940 so threatened to upset approaching domestic self-sufficiency that in January 1941 export-license control was established over shipments to foreign countries. Whereas a moral embargo had been imposed by domestic producers, it was alleged that their customers had made export shipments, thereby depleting aggregate domestic stocks.

The leading potash-bearing raw material used in American fertilizer is potassium chloride. Small amounts of the sulfate and potassium-magnesium sulfate and a still smaller quantity of the nitrate are also utilized. Domestic refinery capacity in 1940 was stated as not sufficient to manufacture all our requirements of high-grade, 60-percent chloride, but mining capacity was great enough to supply the balance in the form of 25-percent manure salts

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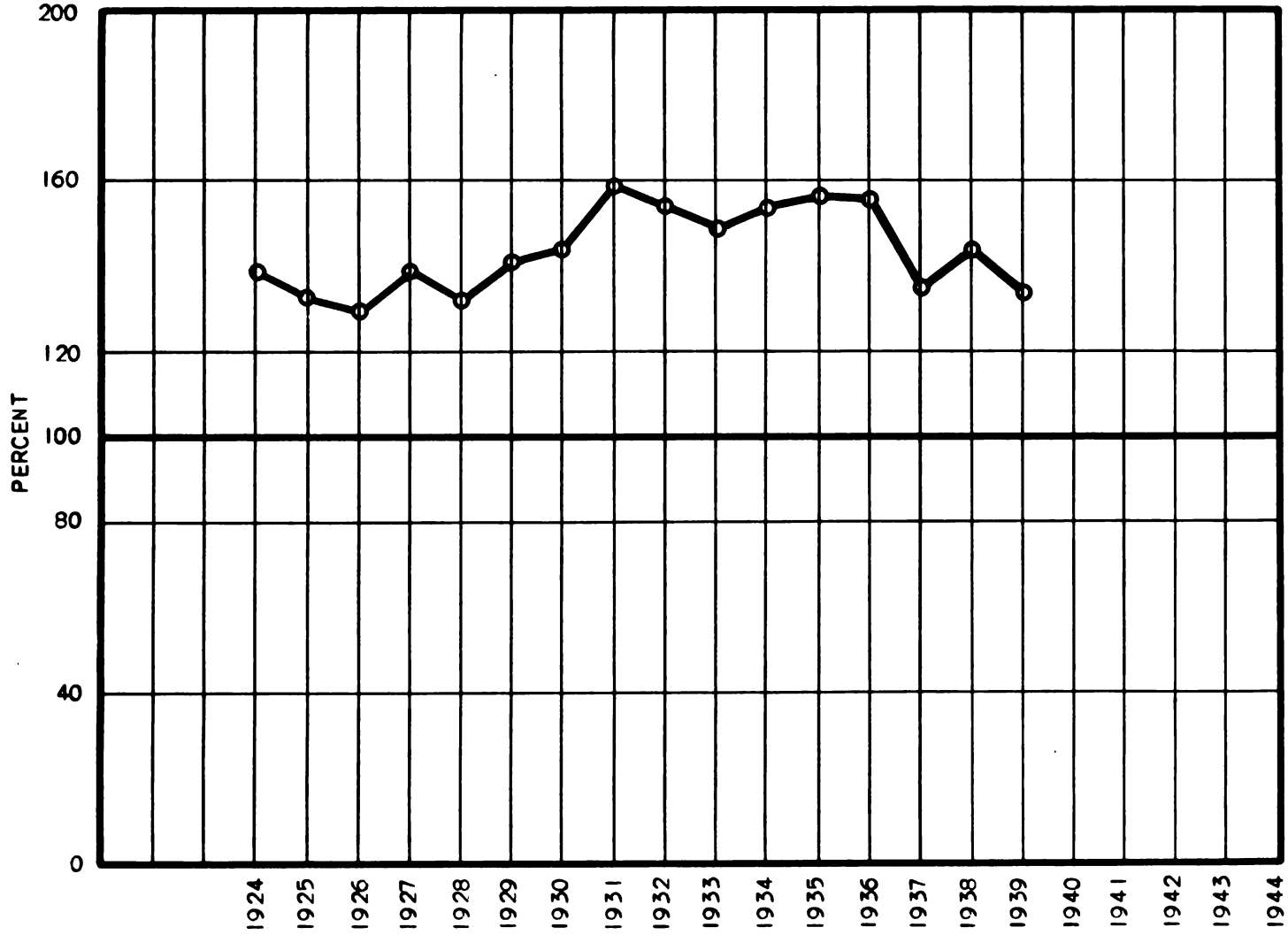

Figure 3.- Ratio of domestic phosphate rock sold or used to apparent domestic consumption.

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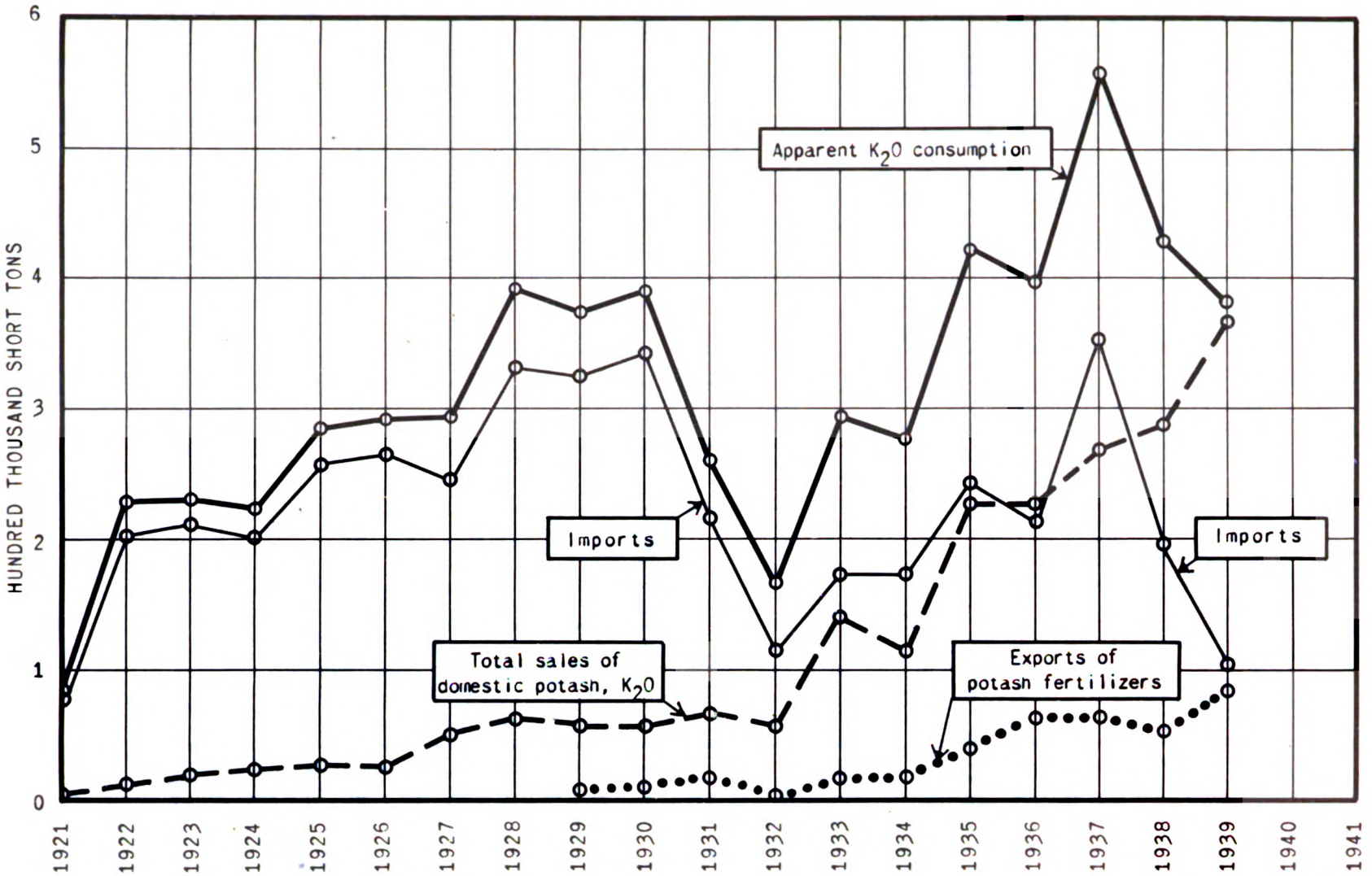

Figure 4.- Statistical summary of potash situation in the United States, 1921-39. (Source of data: Mineral Resources of the United States and Mineral Yearbooks, Geological Survey and Bureau of Mines.)

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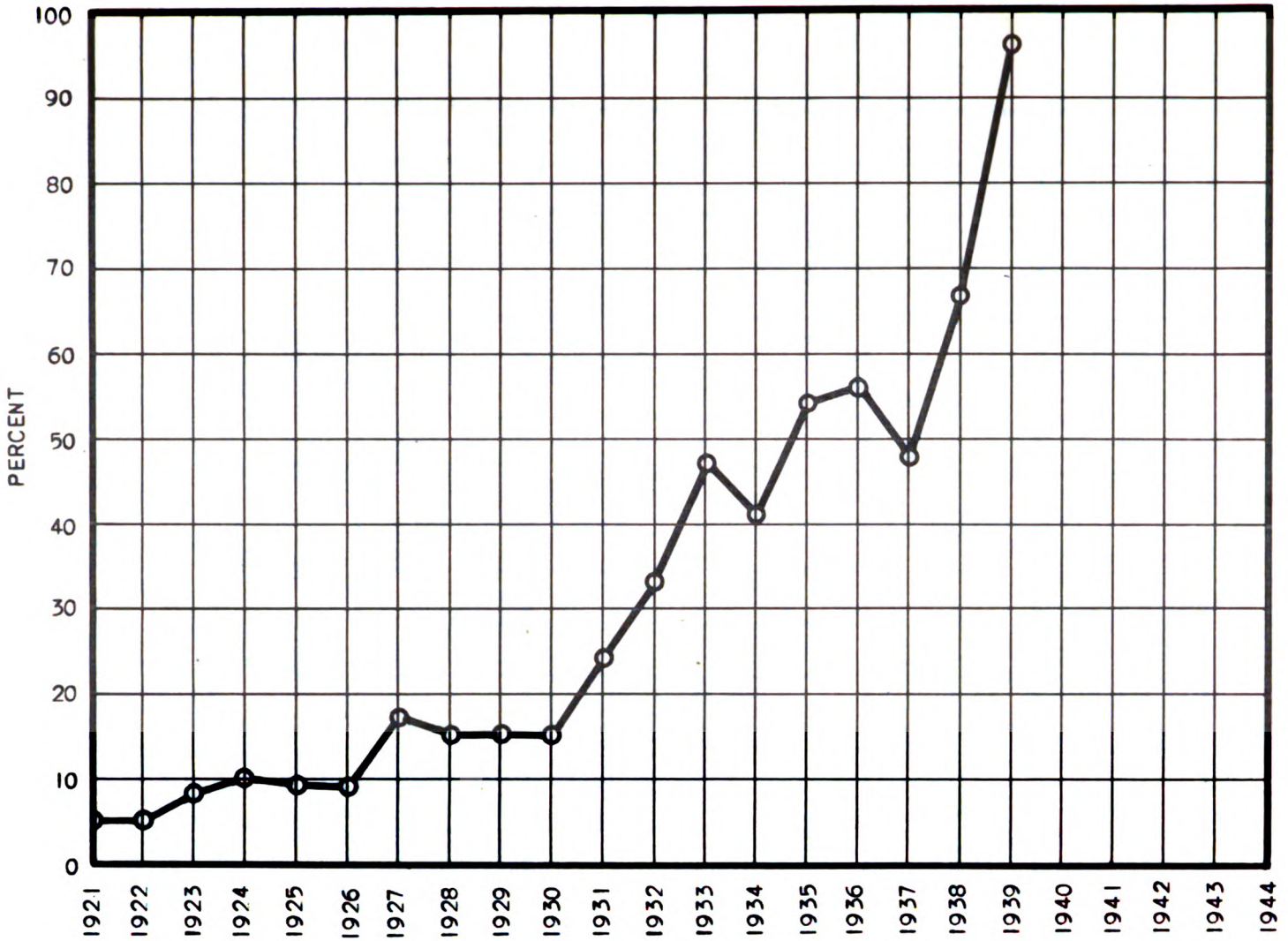

Figure 5.- Ratio of sales of domestic potash to apparent domestic consumption in terms of K_2O.

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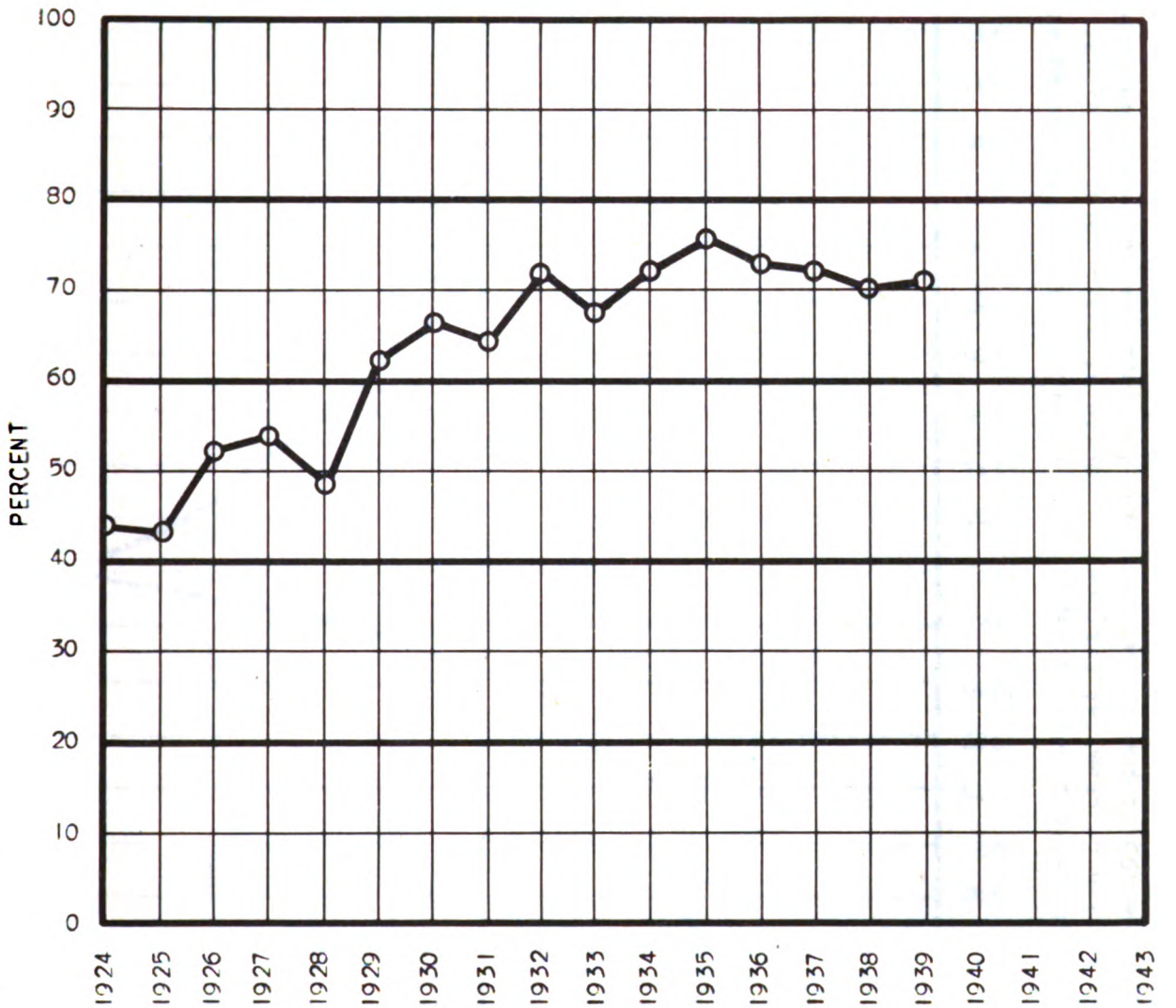

Figure 6.–Ratio of domestic production of chemical nitrogen to apparent domestic consumption of chemical nitrogen. (Source of data: U. S. Tariff Commission.)

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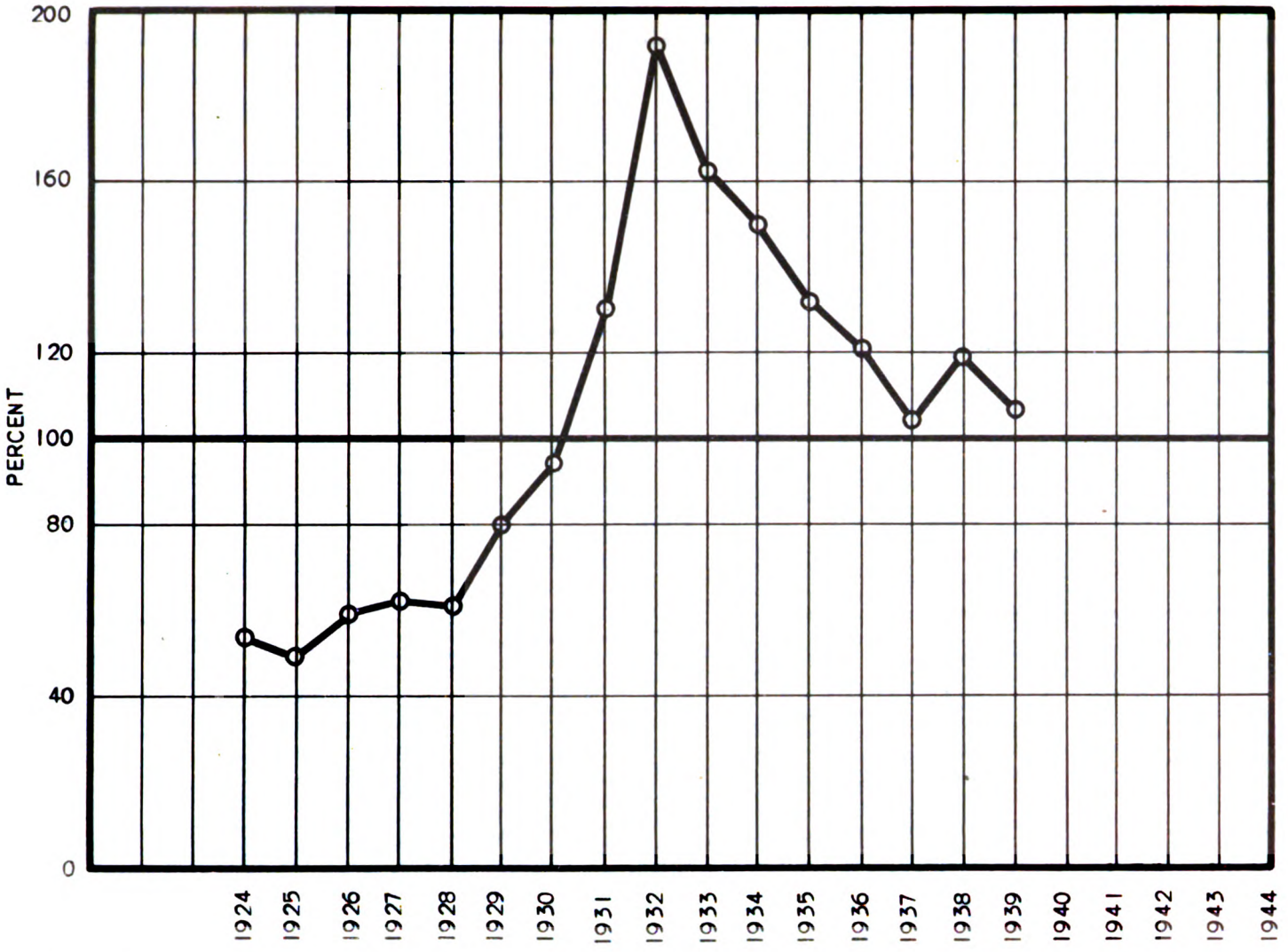

Figure 7.– Ratio of domestic producing capacity of chemical nitrogen to estimated actual domestic consumption of chemical nitrogen. (Source of basic data: U. S. Tariff Commission.) Since 1931 capacity has been less than apparent consumption (production plus imports minus exports).

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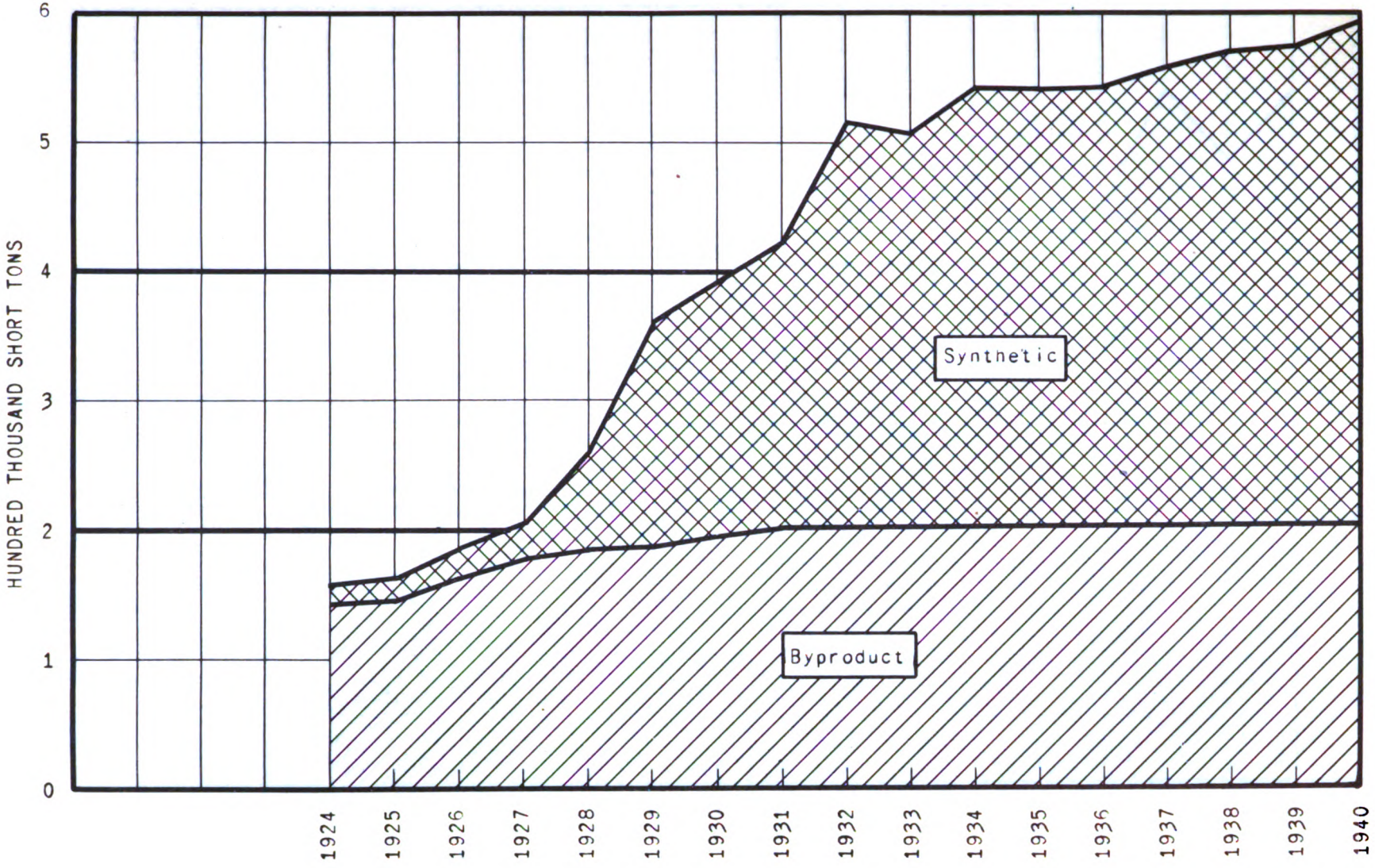

Figure 8.– Chemical nitrogen producing capacity in the United States. (Source of data: U. S. Tariff Commission.)

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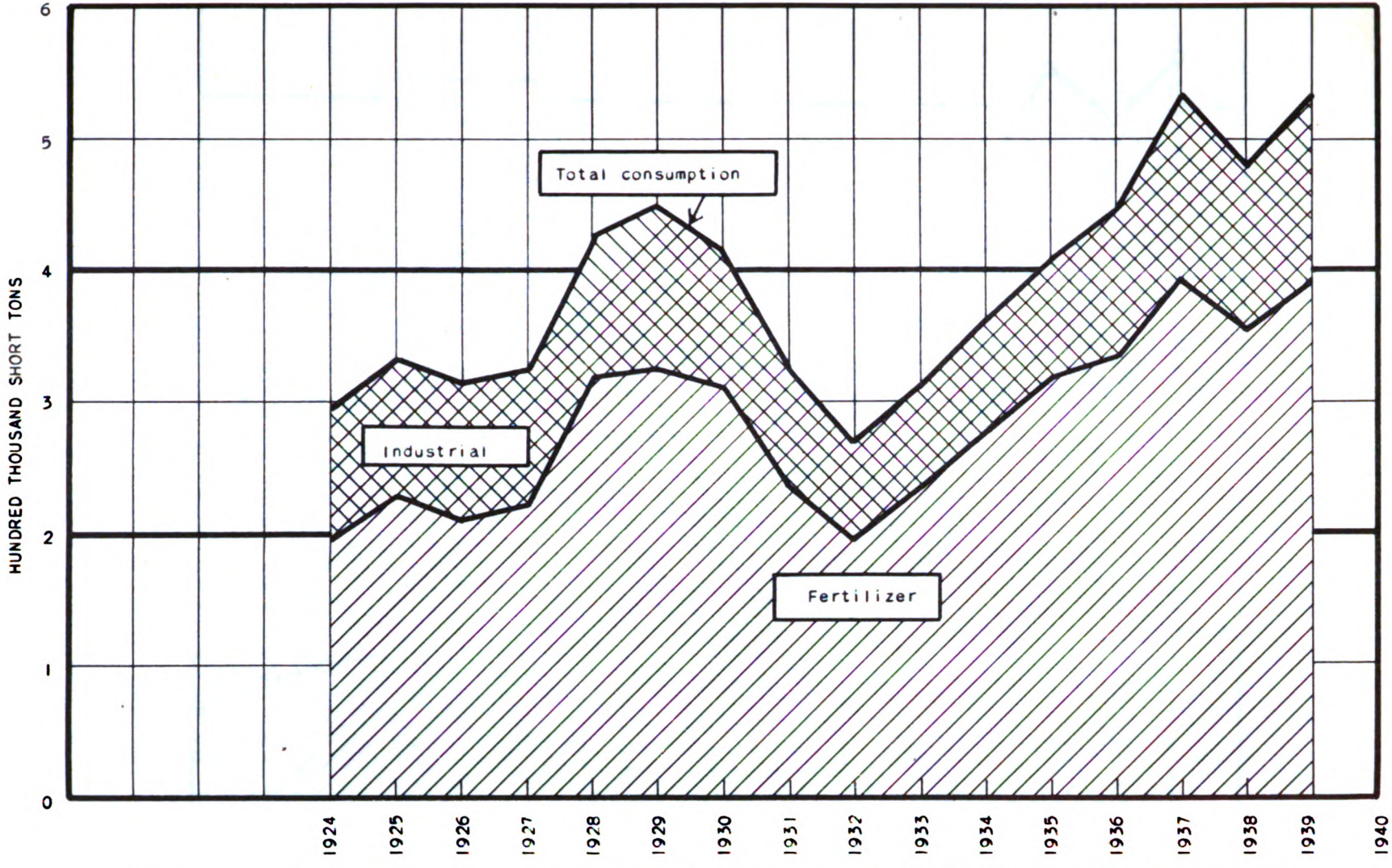

Figure 9.- Consumption of chemical nitrogen in the United States. Source of data: U. S. Tariff Commission.

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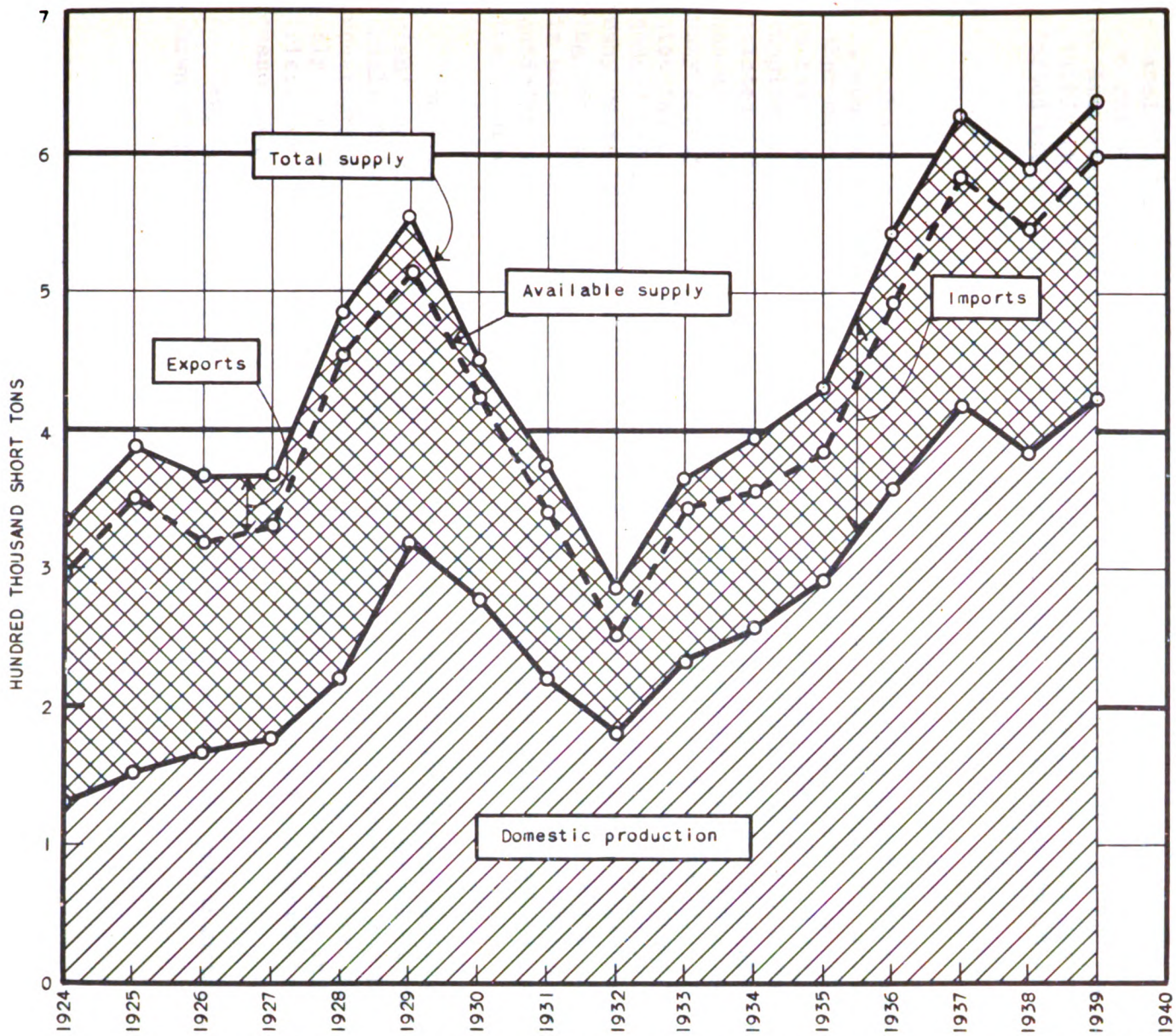

Figure 10.– Statistical summary of chemical nitrogen situation in the United States, 1924–39, in terms of nitrogen. Source of data: U. S. Tariff Commission.

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which are perfectly satisfactory fertilizer material. Additional new production is expected in 1941. The only apparent possible shortage is in potassium sulfate, which is used in the citrus-fruit and tobacco industries, where chloride is not suitable. Before 1939 potassium sulfate and potassium-magnesium sulfate requirements were imported from Europe, and some also entered the United States early in 1940, but later all imports of these salts were cut off and we became dependent on the recently developed American sources. Two American concerns are now making the sulfate from potassium chloride, and a third, which will also manufacture potassium-magnesium sulfate, has now started operations, and an ample supply of both salts is expected in 1941.

Nitrogen

The United States has never produced more than 75 percent of its apparent consumption of chemical nitrogen (nitrogen obtained from air, coal, or other mineral sources by manufacturing processes) (fig. 6) and in recent years it has produced only about 70 percent of its requirements. The rest has been supplied largely by sodium nitrate obtained from Chile. This situation has existed notwithstanding the fact that domestic production capacity apparently has exceeded domestic needs. In recent years, however, capacity has increased only slowly whereas consumption has increased rapidly; consequently, production facilities before the present emergency were only slightly greater than demand (fig. 7). Capacity of byproduct plants has remained stationary for many years (fig. 8), while that of synthetic nitrogen plants, after increasing rapidly from 1927 to 1932, has grown rather slowly. Most of the nitrogen is used in the fertilizer industry (fig. 9), but most of the increased demand anticipated in the present emergency will come from other industries, such as the manufacture of explosives.

To insure enough nitrogen for the national defense program additions to plant capacity are being made including one of 45,000 tons per year at Muscle Shoals (Wilson Dam). Continued flow of Chilean nitrate, however, may be necessary until domestic productive capacity is expanded to take care of not only our fertilizer needs but also the increased demands from other industries. On January 10, 1941, the United States Government contracted to purchase 300,000 tons of Chilean nitrate.

The general statistical situation in the chemical nitrogen industry is shown in figure 10.

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Johnson, Bertrand L., Phosphate Rock. Part I. General Information: Bureau of Mines Inf. Circ. 6256, 1930, 64 pp.

_____. Nitrogen and Its Compounds: Bureau of Mines Inf. Circ. 6385, 1931 33 pp.

_____. Potash: Bureau of Mines Ec. Paper 16, 1933, 78 pp.

_____. Minor Mineral Fertilizer Materials: Bureau of Mines Inf. Circ. 6830, 1935, 35 pp.

_____. The Potash Situation: Bureau of Mines Inf. Circ. 7117, 1940, 6 pp.

Tyler, Paul M., The Fertilizer Industries: Bureau of Mines Inf. Circ. 6834, 1935, 41 pp.

Additional publications on fertilizer raw materials are being prepared.

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